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No. 9

*On Ancient Eclipses.* By P. H. Cowell.

One of the most striking features of Mr. Nevill's recent paper (*Monthly Notices*, lxvi. pp. 404-420) is that, whereas I maintain that the ancient eclipses can only be satisfied by one set of formulæ for the configuration of the node, Sun, and Moon, he produces four systems, and states, on p. 415, that they respectively satisfy, out of twelve eclipses, seven or possibly nine, seven or eight, six at least, but possibly eight, and ten. A moment's consideration will show that Mr. Nevill and I must be using the word "satisfy" in different senses. He is evidently more easily satisfied than I am. On p. 416 he regards as satisfactory any value of  $\Delta\phi$  less than  $2\frac{1}{2}^\circ$ ; translating this into my language he is satisfied if the tabular latitude of the Moon, corrected for the difference of parallaxes at the moment of apparent conjunction in longitude, is less than  $130''$ —for shortness I will say if the residual is less than  $130''$ . Now the whole point of my first paper on eclipses (*Monthly Notices*, lxv. pp. 861-867) is that the residuals can be simultaneously reduced to less than  $50''$ . Mr. Nevill therefore uses the word "satisfy" with its stringency relaxed in the proportion of  $5 : 2$ ; it is no wonder, therefore, that so vast a number of mutually exclusive systems give him this very moderate amount of satisfaction. The same considerations explain Mr. Nevill's treatment of the eclipse of Utica. On p. 867 (*Monthly Notices*, lxv.) I give as the equation arising from this eclipse

$$+23s_F - 38s_D = +39''$$

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where  $s_F$ ,  $s_D$  are the corrections to the secular accelerations of the argument of latitude and mean elongation as adopted in my calculations.

The present tables imply, to those who believe in their accuracy, that  $s_F = -4''$ ; we should then have

$$+23(s_F + 4'') - 38s_D = +131''$$

Therefore I say that because I want residuals less than  $50''$  the eclipse of Utica is evidence in favour of my formulæ as against the present tables. Mr. Nevill, however, would be satisfied by the new residual. He therefore naturally considers (*Monthly Notices*, lxvi. p. 415) that "the epoch" (of the eclipse of Utica) "is so late that it cannot be regarded as of any value."

Again a very slight inspection of the five equations of condition on p. 867 (*Monthly Notices*, lxv.) will show that they can only be satisfied, in my sense, by small corrections to the secular accelerations adopted by me.

In exhibiting more eclipse calculations, I have had to decide whether to adopt a secular acceleration for the Sun in my formulæ or a secular acceleration of the node contrary to gravitational theory. I have preferred the former course, but I wish it to be clearly understood that the ancient eclipses only afford evidence of the relative movements of the Sun, Moon, and node, and not of the position of the equinox. Mr. Nevill's statement

*Lunar Eclipses.*

Ref. No.	T.	T <sup>a</sup> .	T <sup>s</sup> .	g.	ω.	-Ω.	L'.	π'.	L.
1	-25°197527	634°92	-15998	248° 26' 34"	118° 32' 47"	189° 45' 16"	350° 29' 36"	236° 25' 39"	177° 14' 5"
2	-25°187833	634°43	-15980	194 24 7	176 44 49	208 30 17	339 29 1	236 26 38	162 38 39
3	-25°182991	634°18	-15971	344 59 42	205 49 3	217 52 14	153 47 57	236 27 8	332 56 31
4	-24°196615	585°48	-14167	161 49 17	7 49 15	325 45 50	24 1 21	238 7 54	203 52 42
5	-23°214281	538°90	-12510	209 50 12	145 32 4	65 50 6	108 44 2	239 48 15	289 32 10
6	-23°000838	529°04	-12168	184 27 20	346 59 44	118 41 6	232 49 55	240 10 4	52 45 58
7	-22°896527	524°25	-12004	281 28 45	253 15 13	320 26 50	28 6 4	240 20 44	214 17 8
8	-21°809918	475°67	-10374	49 22 29	296 58 34	262 12 21	266 47 23	242 11 48	84 8 42
9	-21°805057	475°46	-10367	209 2 8	326 9 37	271 36 29	81 47 21	242 12 18	263 35 16
10	-21°800209	475°25	-10361	2 29 34	355 16 0	280 59 7	256 19 15	242 12 47	76 46 27
11	-19°992410	399°70	-7991	121 3 4	48 46 3	177 41 6	178 21 52	245 17 38	352 8 1
12	-19°987530	399°50	-7985	289 46 44	78 3 55	187 7 26	354 2 52	24 18 7	180 43 13
13	-19°982709	399°31	-7979	70 21 7	107 0 32	196 26 56	167 36 27	245 18 37	340 54 43
14	-19°726393	389°13	-7676	343 54 39	205 50 58	332 13 20	35 9 56	245 44 51	217 32 17
15	-19°398950	376°32	-7300	359 9 22	11 42 42	245 34 14	303 20 49	246 18 19	125 17 50
16	-16°747069	280°46	-4697	72 22 51	92 39 29	334 53 23	12 57 43	250 49 43	190 8 57
17	-16°666218	277°76	-4629	134 20 51	218 3 22	131 16 21	43 39 21	250 57 58	221 7 52
18	-16°651653	277°28	-4617	244 44 31	305 29 54	159 26 40	208 0 24	250 59 29	30 47 45
19	-16°637903	276°82	-4606	326 13 11	28 2 53	186 2 23	343 0 59	251 0 53	168 13 41

where  $s_F$ ,  $s_D$  are the corrections to the secular accelerations of the argument of latitude and mean elongation as adopted in my calculations.

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5	-23°214281	538°90	-12510	209 50 12	145 32 4	65 50 6	108 44 2	239 48 15	289 32 10
6	-23°000838	529°04	-12168	184 27 20	346 59 44	118 41 6	232 49 55	240 10 4	52 45 58
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10	-21°800209	475°25	-10361	2 29 34	355 16 0	280 59 7	256 19 15	242 12 47	76 46 27
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13	-19°982709	399°31	-7979	70 21 7	107 0 32	196 26 56	167 36 27	245 18 37	340 54 43
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in his footnote to p. 417 (*Monthly Notices*, lxvi.) is perfectly correct; it is true that  $V-V'$  may be altered by about  $300''$ ; but in forming the residual  $V-V'$  has to be multiplied by the small quantity that I have called  $k$ , and the product is generally small. I have therefore substituted for the formulæ on p. 863 (*Monthly Notices*, lxv.) the following :

$$\begin{aligned} g &= 110^{\circ} 19' 38'' + 171791 \ 5794T + 49'' \cdot 8T^2 + 0'' \cdot 050T^3 \\ \omega &= 192 \ 7 \ 25 + 2161 \ 1516T - 45 \cdot 4T^2 - 0 \cdot 044T^3 \\ -\delta &= 326 \ 43 \ 39 + 696 \ 2921T - 7 \cdot 6T^2 - 0 \cdot 007T^3 \\ L' &= 279 \ 54 \ 29 + 12960 \ 2766T + 5 \cdot 2T^2 \\ \pi' &= 279 \ 29 \ 47 + 6186T + 1 \cdot 6T^2 + 0 \cdot 012T^3 \end{aligned}$$

No other formula has been altered; the solar eclipse calculations of this paper are therefore sufficiently explained in my previous paper.

It is an unfortunate fact that in a large number of cases I am unable to agree that the quantities that Mr. Nevill has published in the fourth column of his paper under the heading "Cowell" represent my formulæ. To assist anyone who wishes

Ref. No.	$V-L.$	$V'-L'.$	$V-V'$ $+180^{\circ}.$	$U.$	$\frac{d}{dt}(V-V').$	$\frac{dU}{dt}.$	$\mu.$	$\Sigma =$ $p+p'-\sigma.$	$\Delta =$ Least dis- tance of cen- tres.
1	-17280"	+6628"	+361"	+758"	1541"	+155"	916"	2410"	718"
2	-5042	+7101	-765	+3091	1424	+146	886	2298	3154
3	-4095	-7286	+105	-2912	1861	-184	1003	2721	2887
4	+5358	+4025	+814	+2777	1431	-146	887	2311	2845
5	-8343	-5421	-34	-2180	1445	+147	891	2323	2167
6	-1168	-951	-454	+2780	1414	-145	885	2273	2721
7	-17969	+3817	+478	+3189	1669	-165	949	2540	3220
8	+13491	+3090	+880	-3022	1773	+176	980	2625	3095
9	-8386	-2388	+477	+2217	1445	-147	890	2325	2255
10	+674	+1811	+495	-618	1867	+185	1005	2715	665
11	+15862	-6727	+158	+1876	1507	-152	908	2368	1882
12	-17765	+6816	-560	+976	1701	+168	958	2563	1025
13	+17624	-7117	+637	-660	1698	-168	958	2555	595
14	-5660	+3616	-735	-2619	1865	-184	1002	2734	2678
15	-1096	+6148	-223	+3407	1869	+185	1005	2722	3412
16	+16777	+6026	+625	+3149	1692	-167	957	2564	3194
17	+12572	+3237	+246	-1306	1477	+149	899	2357	1325
18	-15668	-4987	-640	-1817	1523	-154	914	2384	1872
19	-10624	+7188	+950	-2652	1825	+181	992	2684	2732

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to form an independent opinion on this point, I again publish in nearly the same form as in *Monthly Notices*, lxv. p. 866, what I may call the stepping-stones of my calculations, and I publish one calculation *in extenso*, selecting the eclipse of -708 July 17, where I can only believe that Mr. Nevill has made an error. If, therefore, anyone should suspect an error in my calculations, it should be excessively easy to demonstrate its existence.

In the calculations relating to solar eclipses the same reference number is used when more than one eclipse is worked up in connexion with the same record, and small letters are used in addition to the reference number in order to distinguish between the alternatives. Chinese eclipses are marked with capital letters instead of numbers.

T is the time in Julian centuries from 1800 Jan. 0.0 G.M.T. New Style, or 1799 Dec. 20.0 G.M.T. Old Style.

$g, \omega, -\Omega, L', \pi'$  are calculated according to the formulæ given in this paper;  $L = g + \omega + \Omega$ , the Moon's mean longitude.

$V-L, V'-L'$ , are the inequalities of longitude of the Moon and the Sun. The formulæ employed are given in *Monthly Notices*, lxv. pp. 861-7.

$V-V', U$  are the difference of true geocentric longitude of the Moon and Sun and the geocentric latitude of the Moon.

Ref. No.	Date.	$\Delta T$ in units of Julian century $\div 10^8$ $= 0^m.53$ .		Semi- duration $\Delta T_2$ in minutes. m	G.M.T. of middle of eclipse (tabular). h m	Observed <i>minus</i> tabular time.		
						beginning. m	middle. m	end. m
1	-720 Mar. 19	-23	-5	111.3	7 35.2	[-85]		
2	-719 Mar. 8	+54	-22	15.9	9 52.4	...	+34	
3	-719 Sept. 1	-6	-16	66.8	5 53.8	-49		
4	-620 Apr. 21	-57	+20	54.1	14 58.0	-23		
5	-522 July 16	+2	+15	86.4	9 25.5	...	+14	
6	-501 Nov. 19	+31	+19	59.9	9 50.8	-29		
7	-490 Apr. 25	-29	+20	42.4	8 21.2	...	+6	
8	-382 Dec. 22	-50	+18	55.1	17 36.0	?		
9	-381 June 18	-33	+15	83.7	6 52.6	-21	...	-8
10	-381 Dec. 12	-27	+4	103.4	8 35.3	+4		
11	-200 Sept. 22	-10	+12	93.8	5 24.7	-28	...	-34
12	-199 Mar. 19	+33	-6	104.4	11 26.3	-13		
13	-199 Sept. 11	-37	-4	107.6	12 55.9	-30	-34	
14	-173 Apr. 30	+39	-15	73.7	12 6.4	-5	...	+11
15	-140 Jan. 27	+12	-18	42.4	8 22.6	+27		
16	+125 Apr. 5	-37	+19	46.1	7 9.4	+3		
17	+133 May 6	-17	+9	106.0	9 13.9	...	-6	
18	+134 Oct. 20	+42	-12	93.8	9 14.6	...	-29	
19	+136 Mar. 5	-52	+15	71.0	13 54.4	...	+10	

$\frac{d}{dt}(V-V')$ ,  $\frac{du}{dt}$  are the changes of  $V-V'$  and  $U$  in one millionth of a Julian century or 53 minutes of solar time.

$p-p'$  is the difference of parallax.

The place for which parallactic displacements are calculated is then set down, together with its assumed longitude and latitude; next follow the date and the local mean solar and sidereal times.

$v', u'$  are the parallactic displacements in longitude and latitude calculated for the Sun's place with the difference of parallaxes. The subsequent columns explain themselves or are explained in *Monthly Notices*, lxv. 861-7, and the residual is the difference of apparent latitude at apparent conjunction in longitude, the positive sign indicating that the Moon is apparently south of the Sun. Finally the equation of condition is set down.

The calculations for lunar eclipses begin as in the case of solar eclipses; subsequently  $\mu$ ,  $\Sigma = p + p' - \sigma$ ,  $\Delta$  are the semi-diameters of the Moon and shadow, and the least distance between their centres.

$$\mu = 0.273 \times \text{Moon's parallax.}$$

$$\sigma = 960'' + 16'' \cos g'; p' = g'$$

Ref. No.	Observed magnitude.	Tabular magnitude.	Observed <i>minus</i> tabular magnitude.		Observed <i>minus</i> tabular magnitude with allowance for increment of Earth's shadow.		Corresponding corrections to assumed secular acceleration.	
			(a)	(b)	(a)	(b)		
1	total	1.42					"	"
2	3 digits = 0.25	0.02	+0.23					
3	more than half	0.42	+0.09?	...	+0.07		-2.4	
4	0.25	0.20	...	+0.05	...	+0.03	...	+1.1
5	0.5	0.59	...	-0.09	...	-0.11	..	-4.4
6	0.25	0.25	...	0.00	...	-0.02	...	-0.8
7	2 digits = 0.17	0.14	...	+0.03	...	+0.01	...	+0.4
8	small	0.26						
9	—	0.54						
10	total	1.52						
11	partial	0.77						
12	total	1.30						
13	total	1.52						
14	7 digits = 0.58	0.53	+0.05	...	+0.03	...	-1.6	
15	3 digits = 0.25	0.16	+0.09	...	+0.07	...	-4.0	
16	0.17	0.17	—	0.00	...	-0.02	...	-1.5
17	total	1.07						
18	[0.33]	0.78	-0.11?					
19	0.50	0.48	...	+0.02	...	0.00	...	0.0



$\Delta$  = latitude of Moon at conjunction in longitude as inferred from the values of  $V - V' + 180^\circ$ ,  $U$ ,  $\frac{d}{dt}(V - V')$ ,  $\frac{du}{dt}$  and diminished by one half per cent., to represent multiplication by the cosine of the inclination of the Moon's orbit.

$\Delta T$  = interval from the instant chosen for calculation to the instant of conjunction in longitude.

$\Delta T_1$  = interval from conjunction in longitude to the middle of the eclipse.

$\Delta T$ ,  $\Delta T_1$  are expressed in units of a Julian century  $\times 10^{-8} = 0.53$  solar minutes

$$\Delta T = 100 (V - V' + 180^\circ) \div \frac{d}{dt} (V - V')$$

$\Delta T_1 = \Delta \div \frac{dU}{dt}$ , the sign of  $\Delta T_1$  being negative if  $U$  and  $\frac{dU}{dt}$  are of the same sign. To obtain this formula 100 times squared sine of the inclination of the relative orbit is taken as unity.

$\Delta T_2$  is the semi-duration of the eclipse in solar minutes; the semi-chord of the eclipse is  $\sqrt{(\Sigma + \mu)^2 - \Delta^2}$ . This is turned into time by dividing by  $\frac{d}{dt} (V - V')$ , diminishing the quotient by

*Solar Eclipses.*

Ref. No.	T.	T <sup>2</sup> .	T <sup>3</sup> .	<i>g.</i>	<i>ω.</i>	−Ω.	L'	π'.	L.
				<sup>°</sup> <sup>'</sup> <sup>''</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>	<sup>°</sup> <sup>'</sup> <sup>''</sup>
1a	−29°225902	854°15	−24963	315 30 27	52 45 17	317 50 55	46 12 53	229 34 23	50 24 49
1b	−29°154776	850°00	−24782	56 41 48	119 47 17	95 25 30	86 47 57	229 41 39	81 3 35
1	−28°613889	818°75	−23428	46 55 40	127 13 5	61 38 33	119 6 7	230 36 50	112 30 12
2	−25°615143	656°14	−16807	42 51 29	131 15 23	101 58 53	76 1 37	235 43 0	72 7 59
A	−25°074254	628°72	−15765	34 5 31	138 39 13	68 11 41	108 24 25	236 38 15	104 33 3
3	<b>−24°775033</b>	<b>613°81</b>	<b>−15207</b>	<b>233 10 23</b>	<b>134 45 28</b>	<b>286 50 45</b>	<b>78 24 40</b>	<b>237 8 48</b>	<b>81 5 6</b>
4	<b>−24°594795</b>	<b>604°90</b>	<b>−14877</b>	<b>231 2 58</b>	<b>137 13 52</b>	<b>275 35 12</b>	<b>89 15 53</b>	<b>237 27 13</b>	<b>92 41 38</b>
5a	−24°082222	579°95	−13966	29 57 14	334 36 44	187 1 40	182 15 3	238 19 34	177 32 18
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8	<b>−22°022948</b>	<b>485°01</b>	<b>−10681</b>	<b>271 49 57</b>	<b>98 0 3</b>	<b>210 9 21</b>	<b>157 33 35</b>	<b>241 50 1</b>	<b>159 40 39</b>
9	<b>−21°984961</b>	<b>483°34</b>	<b>−10626</b>	<b>39 9 44</b>	<b>326 3 53</b>	<b>283 37 53</b>	<b>85 7 6</b>	<b>241 53 53</b>	<b>81 35 44</b>
10a	<b>−21°624371</b>	<b>467°61</b>	<b>−10112</b>	<b>32 4 42</b>	<b>330 57 1</b>	<b>261 5 50</b>	<b>106 36 46</b>	<b>242 30 46</b>	<b>101 55 53</b>
10b	<b>−21°596051</b>	<b>466°39</b>	<b>−10072</b>	<b>226 19 59</b>	<b>140 58 32</b>	<b>315 52 28</b>	<b>46 9 9</b>	<b>242 33 39</b>	<b>51 26 3</b>
11	−21°083482	444°51	−9372	23 22 5	338 17 47	227 18 7	138 59 56	243 26 4	134 21 45
C	−20°984025	440°33	−9240	324 4 35	215 24 29	59 40 29	119 31 17	243 36 14	119 48 35
D	−19°864262	394°59	−7838	73 3 31	98 7 40	65 33 7	111 47 1	245 30 44	105 38 4
E	−19°797951	391°96	−7760	36 33 19	136 14 16	193 48 45	339 1 36	245 37 31	338 58 50
12	−16°025461	256°82	−4116	262 33 23	104 54 19	290 37 57	71 22 12	252 3 35	76 49 45

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one half per cent., and the unit changed to solar minutes by multiplying by 53.

$$\text{Hence} \quad \Delta T_2 = 52.7 \sqrt{\{(\Sigma + \mu)^2 - \Delta^2\}} \div \frac{d}{dt}(V - V').$$

The Greenwich mean time of the middle of the eclipse is found by turning  $T + \Delta T + \Delta T_1$  from Julian centuries into hours and minutes.

The next three columns give the observed *minus* tabular times; the observed times are taken without change from Professor Newcomb, except that the position of the observers of eclipse No. 8 is considered unknown; the phase observed is sometimes uncertain; that which I have assumed is indicated by the heading.

The next two columns give the observed and tabular magnitudes; the tabular magnitude being calculated from the formula  $\frac{1}{2} + \frac{\Sigma - \Delta}{2\mu}$ ; the difference is entered in column *a* or column *b*, according as a displacement of the Sun relatively to the node in the forward direction would decrease or increase the magnitude of the eclipse; in other words column *a* corresponds to cases

Ref. No.	V-L.	V'-L'.	V-V'.	U.	$\frac{d}{dt}(V-V')$	$\frac{dU}{dt}$	p-p'.
1a	-12853"	+ 423"	+ 1840"	+ 1475"	1799"	+ 177"	3595"
1b	+ 15650	- 4373	- 639	- 224	1756	- 173	3553
1	+ 13882	- 6805	- 3068	+ 709	1788	- 177	3585
2	+ 12807	- 2493	+ 1282	+ 743	1804	- 178	3601
A	+ 11070	- 5673	+ 2861	+ 1367	1828	- 181	3626
3	- 14173	- 2599	- 1948	+ 1269	1497	+ 150	3304
4	- 13705	- 3783	+ 2423	+ 1432	1490	+ 150	3298
5a	+ 9414	- 6141	- 1410	+ 2195	1833	+ 181	3635
5	- 2471	+ 1116	- 188	+ 1590	1875	+ 185	3672
B	+ 6435	- 6698	+ 2740	+ 2347	1857	- 184	3659
6	- 2758	- 196	+ 3555	+ 1670	1873	+ 185	3670
6a	- 17280	+ 952	+ 3524	+ 626	1696	- 167	3495
7	- 17124	- 6569	+ 1403	+ 2644	1599	- 159	3408
8	- 17330	- 7259	- 2447	+ 1486	1625	+ 162	3437
9	+ 11803	- 2812	+ 1933	+ 2669	1816	+ 179	3613
10a	+ 10040	- 4982	- 1831	+ 1772	1835	+ 181	3631
10b	- 13237	+ 2012	+ 3775	+ 1213	1479	+ 149	3283
11	+ 7780	- 6998	- 1913	+ 1110	1850	+ 182	3650
C	- 10147	- 5943	- 3166	+ 1185	1823	- 180	3624
D	+ 17981	- 5157	+ 1001	+ 1248	1690	- 167	3491
E	+ 10254	+ 7223	+ 2865	+ 1225	1818	- 180	3622
12	- 17967	+ 84	+ 1602	+ 805	1594	+ 159	3396



when the Moon is partially eclipsed on its south limb at the ascending node or on its north limb at the descending node, and column *b* to the two remaining cases.

In this paper I will begin with the discussion of the lunar eclipses first.

An error of 1'' in the secular acceleration of the mean elongation will produce an error of  $T^2 \div 30$  minutes in the tabular time, a quantity that varies from 21 minutes for the first eclipse to 9 minutes for the last eclipse. The column of discordances for the middle of the eclipse is satisfactory; the other columns would indicate that the secular acceleration of the mean elongation requires an increase of less than one second; but this correction is diminished if the radius of the shadow be increased by two per cent. for the Earth's atmosphere. The result for the first eclipse may fairly be rejected, as greatly discordant from the others. The probable error seems to be about 2'' for the secular acceleration from each observed time, and the mean result is a correction of about +0''·5 to the value +6''·8 assumed in my formulæ, with a probable error of less than  $\pm 0''\cdot 5$ .

Ref. No.	Place.	Lat. N.	Long. E.	Date.	Local Mean Time in Degrees.	$h$ = Local Sidereal Time in Degrees.	$v'$ .
1a	Babylon	32° 26'	44° 13'	- 1123 May 18	18° 8' 19	65° 0' 34	+ 538 + 931 - 120 = + 1349
1b	"	32 26	44 13	- 1116 June 28	334° 5' 93	61° 3' 92	+ 59 - 1176 - 70 = - 1187
1	"	32 26	44 13	- 1062 July 31	297° 7' 56	56° 8' 58	- 355 - 2518 - 13 = - 2886
2	Nineveh	36 24	43 0	- 762 June 15	7° 6' 93	83° 7' 20	+ 218 + 405 - 44 = + 579
A	Heeng-yang	34 12	109 3	- 708 July 17	63° 2' 04	171° 6' 11	- 238 + 2598 + 126 = + 2486
3	Nineveh	36 24	43 0	- 678 June 17	305° 1' 43	23° 5' 54	+ 168 - 2064 - 111 = - 2007
4	Susa	32 6	48 18	- 660 June 27	88° 8' 45	178° 1' 10	+ 22 + 2675 + 119 = + 2816
5a	Larissa	36 6	43 13	- 609 Sept. 30	346° 1' 39	168° 3' 90	- 864 - 592 + 24 = - 1432
5	"	36 6	43 13	- 602 May 18	336° 3' 29	25° 7' 86	+ 564 - 1155 - 122 = - 713
B	Heeng-yang	34 12	109 3	- 600 Sept. 20	68° 4' 24	241° 6' 65	- 820 + 2728 - 102 = + 1806
6	Iconium	37 48	32 24	- 584 May 28	103° 9' 14	164° 2' 25	+ 450 + 2695 + 86 = + 3231
6a	"	37 48	32 24	- 556 May 19	82° 9' 62	134° 5' 41	+ 534 + 2624 + 13 = + 3171
7	Athens	37 56	23 38	- 430 Aug. 3	86° 3' 27	213° 2' 40	- 485 + 2573 + 42 = + 2130
8	"	37 56	23 38	- 403 Sept. 3	320° 3' 81	117° 9' 41	- 774 - 1584 + 115 = - 2243
9	Rome	41 54	12 29	- 399 June 21	120° 2' 96	205° 4' 14	+ 96 + 2205 + 107 = + 2408
10a	Thebes	38 22	23 20	- 363 July 13	329° 0' 54	75° 6' 67	- 239 - 1345 + 2 = - 1582
10b	"	38 22	23 20	- 360 May 12	108° 7' 34	154° 8' 86	+ 563 + 2342 + 40 = + 2945
11	Syracuse	37 3	15 16	- 309 Aug. 15	310° 4' 49	89° 4' 48	- 648 - 2061 + 89 = - 2620
C	Heeng-yang	34 12	109 3	- 299 July 26	284° 3' 25	43° 8' 46	- 383 - 2760 - 40 = - 3183
D	"	34 12	109 3	- 187 July 17	48° 0' 12	159° 7' 96	- 275 + 2102 + 122 = + 1949
E	"	34 12	109 3	- 180 Mar. 4	51° 3' 51	30° 3' 78	+ 775 + 2176 - 25 = + 2926
12	Utica	37 10	10 0	+ 197 June 3	23° 3' 11	94° 6' 81	+ 263 + 1025 - 27 = + 1261